

Midterm 1 Study Guide

The test covers all the material discussed so far up to and including section 5.1 and homeworks 1 through 3. The following set of questions is meant to help guide your study and is not meant to be exhaustive of all the possibilities.

1. Be able to write a SISO Python program that performs simple prescribed tasks (the `isPrime` and `lengthGreaterThan10` kinds of programs).
2. Describe the intended behavior of the programs named `yesOnString`, `notYesOnSelf`. Then:
 - Prove that the program `notYesOnSelf` cannot exist.
 - Show how we can write the program `notYesOnSelf` by using `yesOnString` as a helper.
 - Explain why `yesOnString` cannot exist.
3. Describe reasonable ways to encode each of the following as a single string. Explain both the encoding and the decoding process.
 - A pair of strings of arbitrary length
 - A arbitrary-length list of positive integers
 - A graph, and a weighted graph (page 48)
 - An arbitrary number of strings of arbitrary length
4. Provide precise definitions for each of the following, as well as at least two examples for each:
 - An *alphabet* Σ .
 - A *string* over an alphabet Σ .
 - A *language* over an alphabet Σ (hint: lots of good examples on page 51).
 - The language L^* for a given language L .
 - The language LM for given languages L and M .
 - The language \bar{L} for a given language L over an alphabet Σ .
 - A *computational problem* over an alphabet Σ .
 - What it means for a program P to *solve* a given computational problem F .
 - A *decision problem* over an alphabet Σ .
 - The language L_D for a decision problem D .
 - *positive* and *negative* instances of a decision problem.
 - The problem `isMEMBER(L)` for a given language L over an alphabet Σ .
5. Define what it means for a language to be *decidable*, and what it means for it to be *recognizable*.
6. Prove that if a language L is decidable, then:

- The complement language \bar{L} is also decidable
 - If another language M is decidable then the intersection and union languages $L \cap M$, $L \cup M$ are both decidable.
7. Prove that if L is decidable then L is also recognizable.
 8. Provide a precise definition of a *Turing Machine* over an alphabet Σ .
 9. Be able to describe the computation of a Turing Machine based on its state diagram (see p. 76).
 10. Be able to write the state diagrams for Turing Machines that accomplish simple tasks.
 11. Explain the difference between *accepters* and *transducers* and provide examples of each.
 12. Can a problem “loop”? What does that mean? What about a Turing Machine? What about a Python program?